



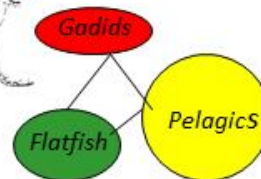
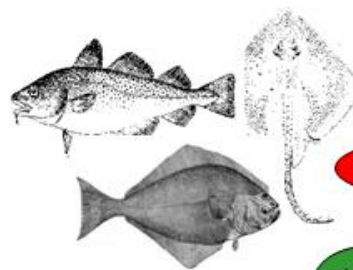
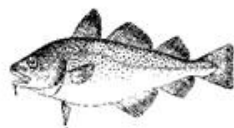
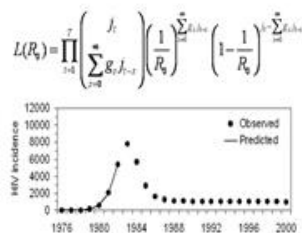
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Ecosystem Science Program Review **Ecosystem Modeling**

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Ecosystem Modeling: Living Marine Resource Management



Data-limited
Calculations

Biomass
dynamics
models

Age/Size
Structured
Models

Age/size
Models
w/
external
factors

Multi-
species
Models

Biophysical
Models

Aggregate
Biomass
Models

Food
Web
Models

Biogeo-
chemical
Models

Full
System
Models

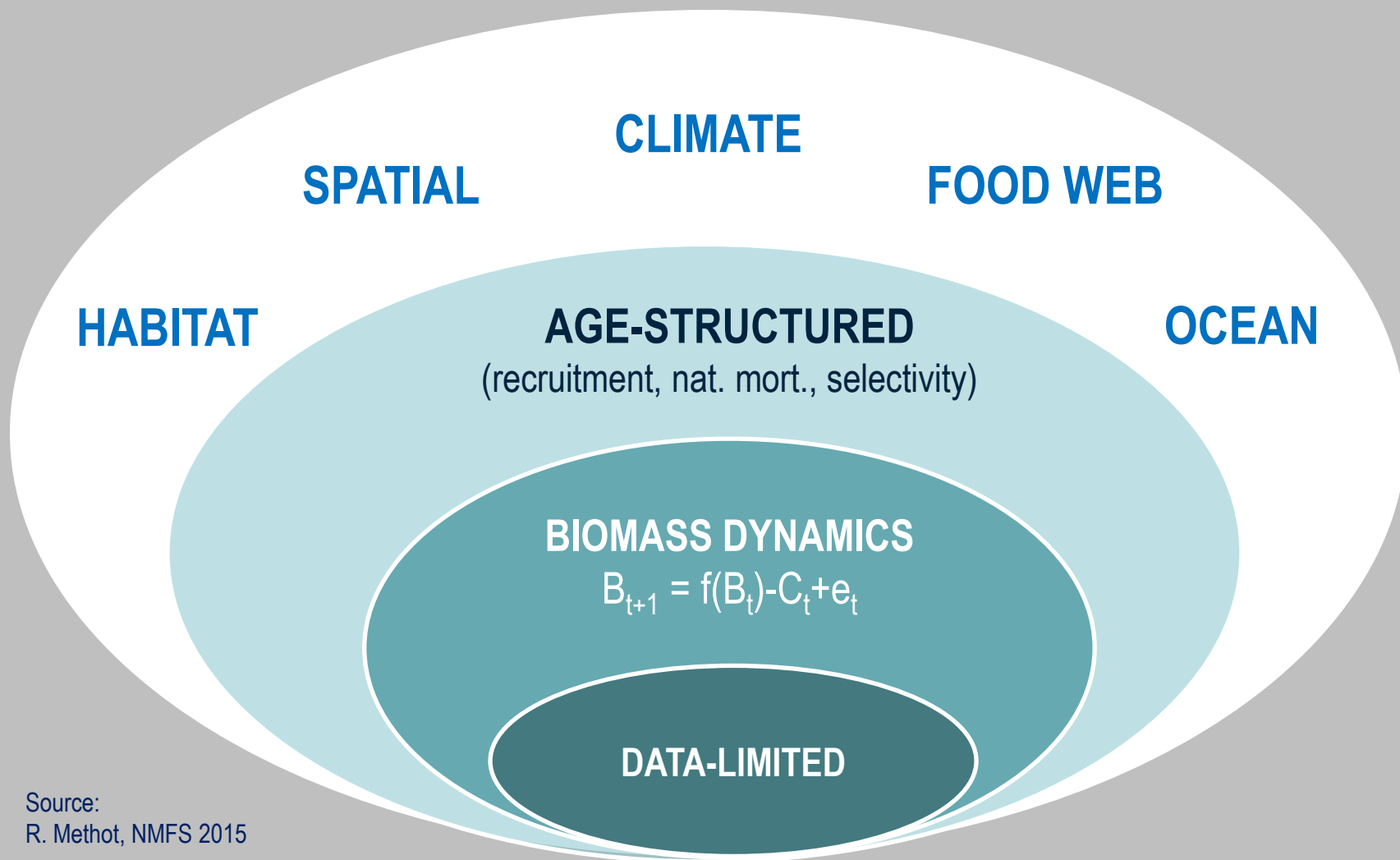
Stock Assessment/Single Species Models

Ecosystem Assessment/Multi-species model



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Onion of Model Simplifications




Source:
R. Methot, NMFS 2015



Ecosystem Modeling: Living Marine Resource Management

The primary reason to use **Ecosystem Modeling (EM)**

is to establish of a transparent connection between single species and ecosystem-based advice in a stock assessment or Integrated Ecosystem Assessment context.



Application as operating models for Management Strategy Evaluation and skill assessment.

Application of a range of models for multiple model inference to deal with uncertainty

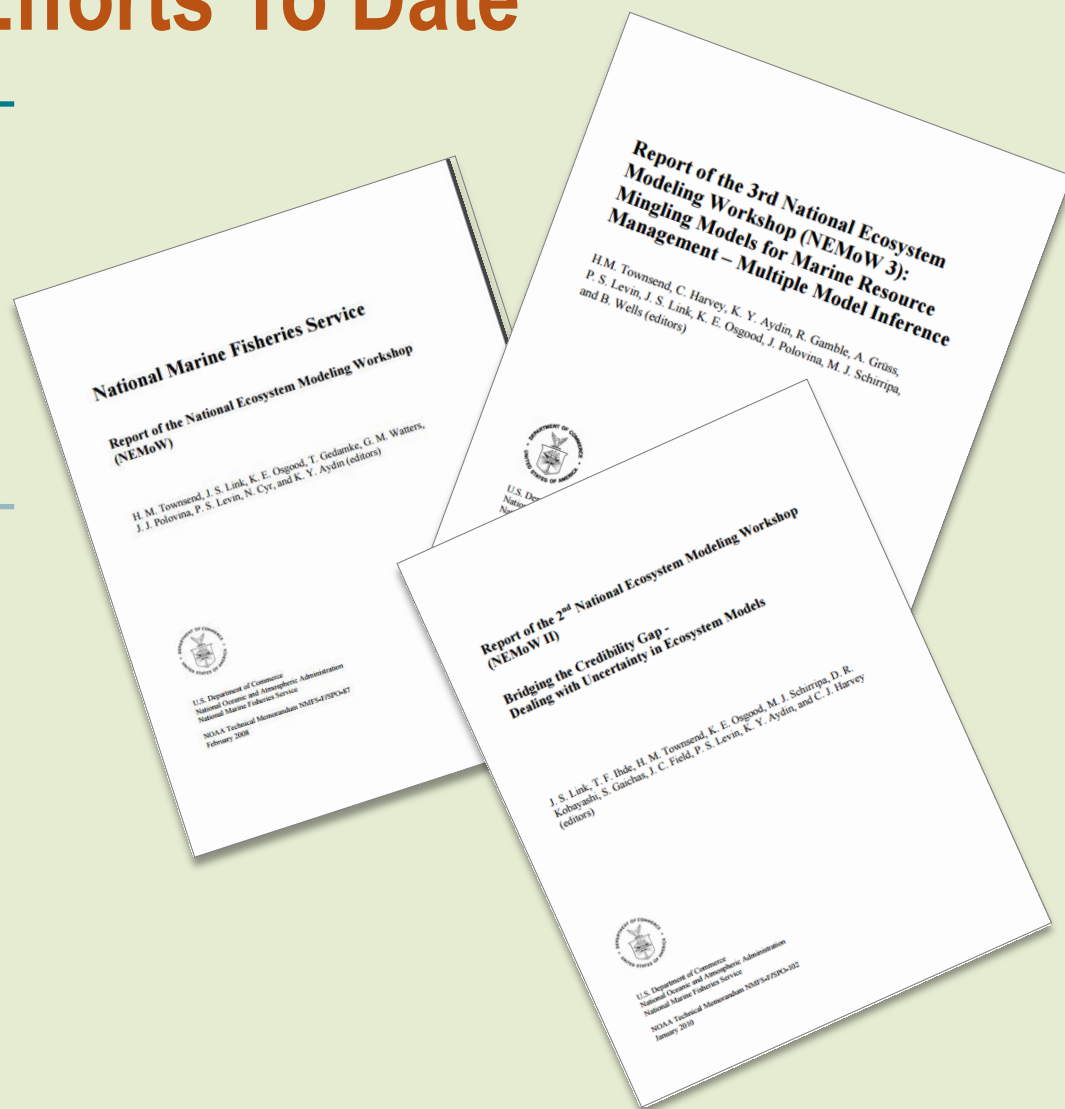
Application for risk assessment and trade-off evaluation in a bioeconomic context.

EM Coordination Efforts To Date

Primarily effort

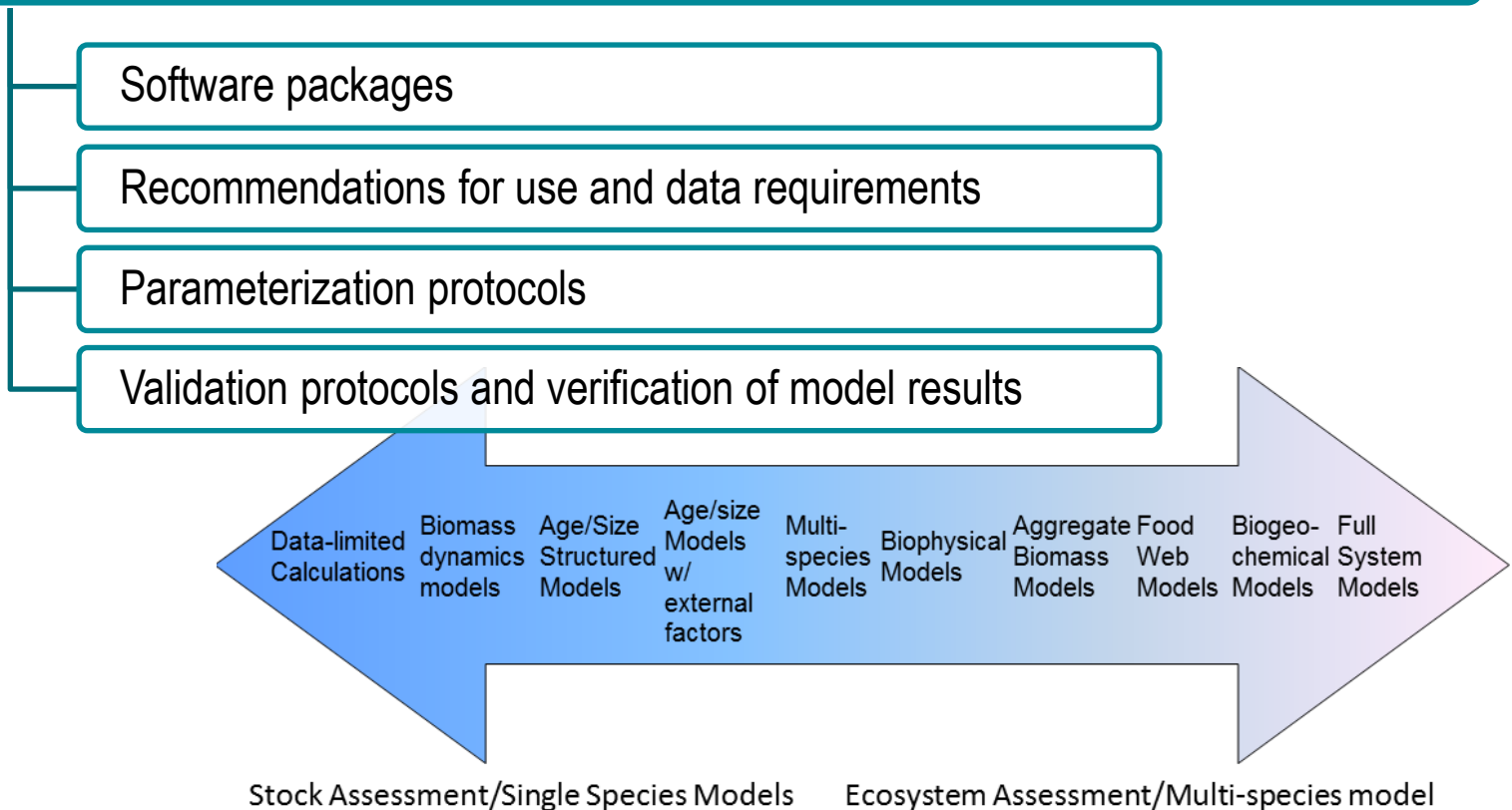
has been through National Ecosystem Modeling Workshops (NEMoWs) in 2007, 2010, and 2014.

NEMoW was designed as a NMFS-wide, national workshop to examine NMFS ecosystem, bio-physical and multispecies modeling approaches to explore the establishment of ecosystem modeling standards of use and review for living marine resource management applications.



1st National Ecosystem Modeling Workshop

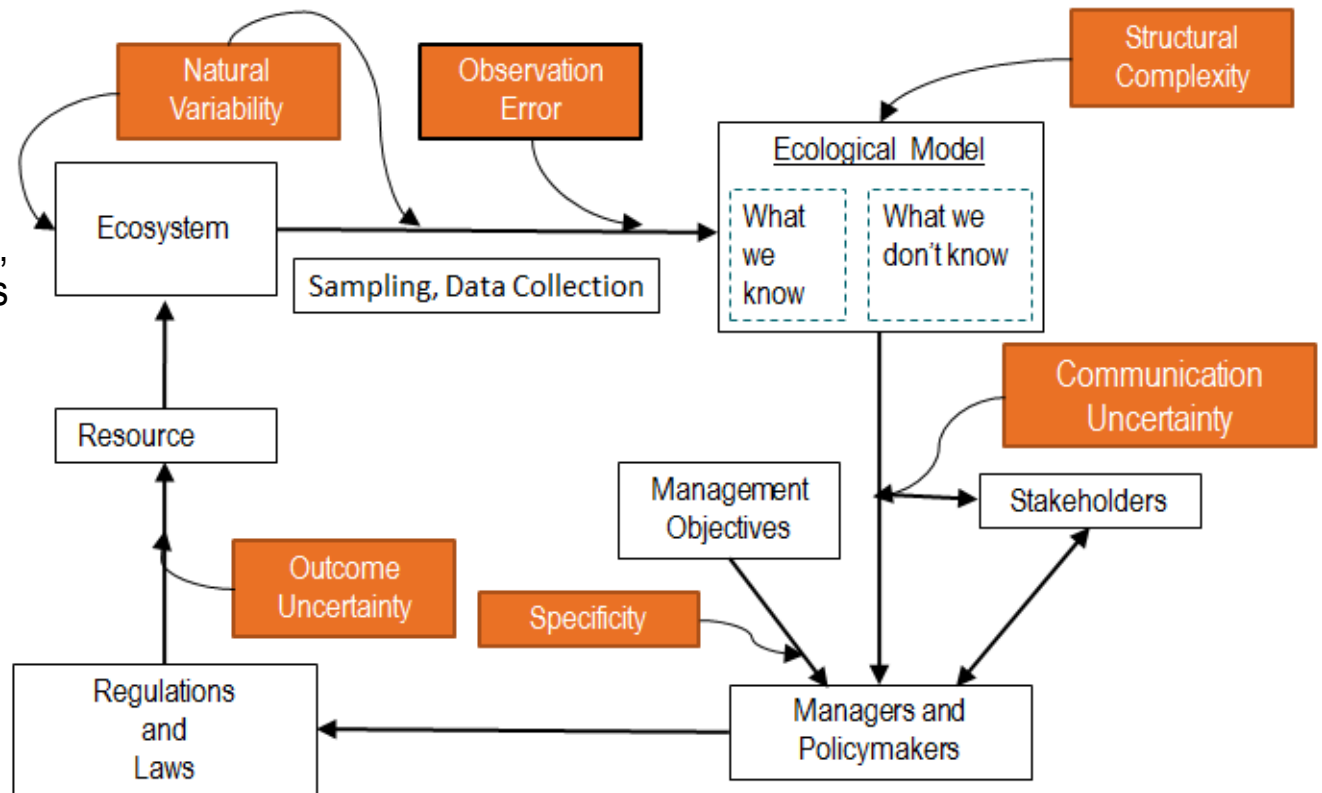
Initiate development of a standardized approach for EM across NMFS and examine:



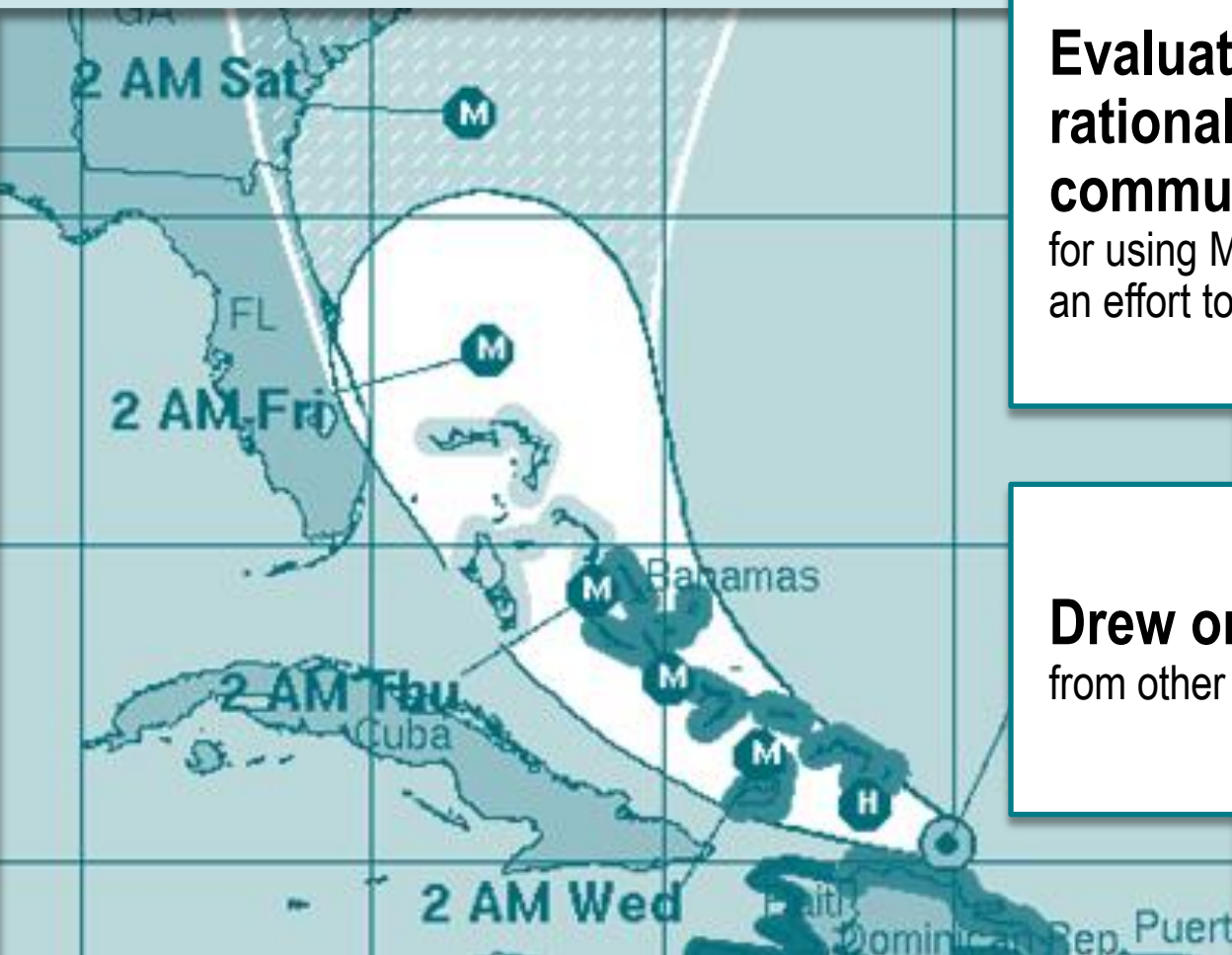
NEMoW 2 – Dealing with Uncertainty

Key for EMs to be used

in providing ecosystem-based LMR management advice is to ensure that all stakeholders, reviewers, managers and scientists using them have full confidence in what the models are doing in general and that the models have been applied appropriately in specific instances.



NEMoW 3 - Multiple Model Inference



Evaluating methods, rationales, and communication methods for using MMI in an LMR context in an effort to reduce uncertainty

Drew on expertise from other disciplines

Major Recommendations from NEMoWs



Formally support/expand dedicated EM efforts at Centers

Adopt a National Standards of EM use

Establish regular NEMoWs

Identify and note sources of EM uncertainty as a must for EM use and review

Adopt Multiple Model Inference (MMI) best practices

Perform simulation studies to evaluate the skill of models to be used for MMI

Major Outcomes from NEMoWs

**Networking and
swapping**
of best practices

**Vehicle
to advance**
ecosystem modeling
and ecosystem-oriented
efforts

During NEMoW
1, 2 out of 7 Centers
(and Habitat Conservation Office)
had **dedicated EM efforts/groups**,
there are now 4.5(+)
out of 7 such groups

**At least 3 centers
have had
formal review**
of ecosystem models
so that Councils can
use the EMs



ToR 1: Goals for Ecosystem Modeling

Conduct science to understand ecosystems

- Modeling the processes, drivers, threats, status, and trends of our ecosystems

Explore and address trade-offs within an ecosystem

- Establish sufficient EBFM modeling capacity to analyze trade-offs
- Develop Management Strategy Evaluation capabilities to better conduct ecosystem-level analyses to provide ecosystem-wide management advice

Incorporate ecosystem considerations into management advice

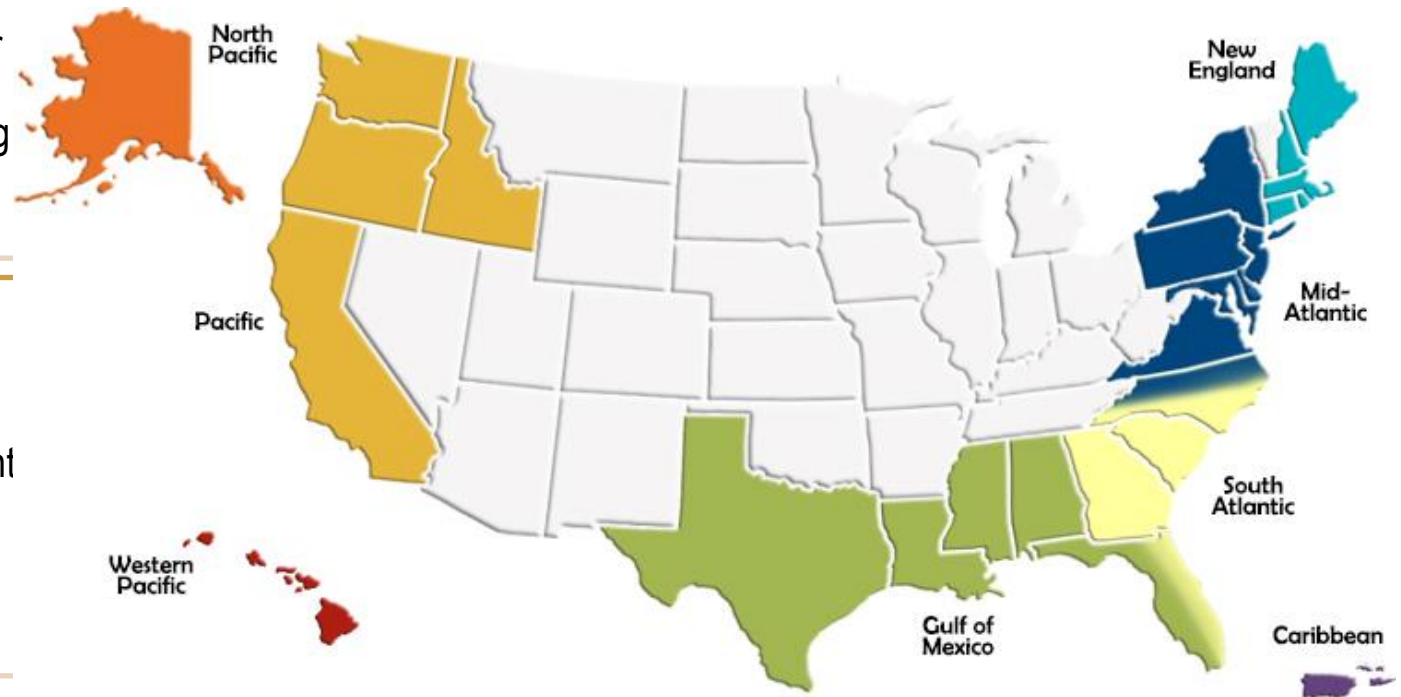
- Develop and monitor Ecosystem-Level Reference Points
- Incorporate ecosystem considerations into appropriate LMR assessments, control rules, and management decisions
- Provide systematic advice for other management considerations, particularly applied across multiple species within an ecosystem

ToR 2 & 3: Integration and Addressing Needs

MAJOR GOALS OF ECOSYSTEM MODELING COORDINATION

1 Ensuring Centers have adequate capacity for developing and applying models.

2 Ensuring uptake by regional management bodies.

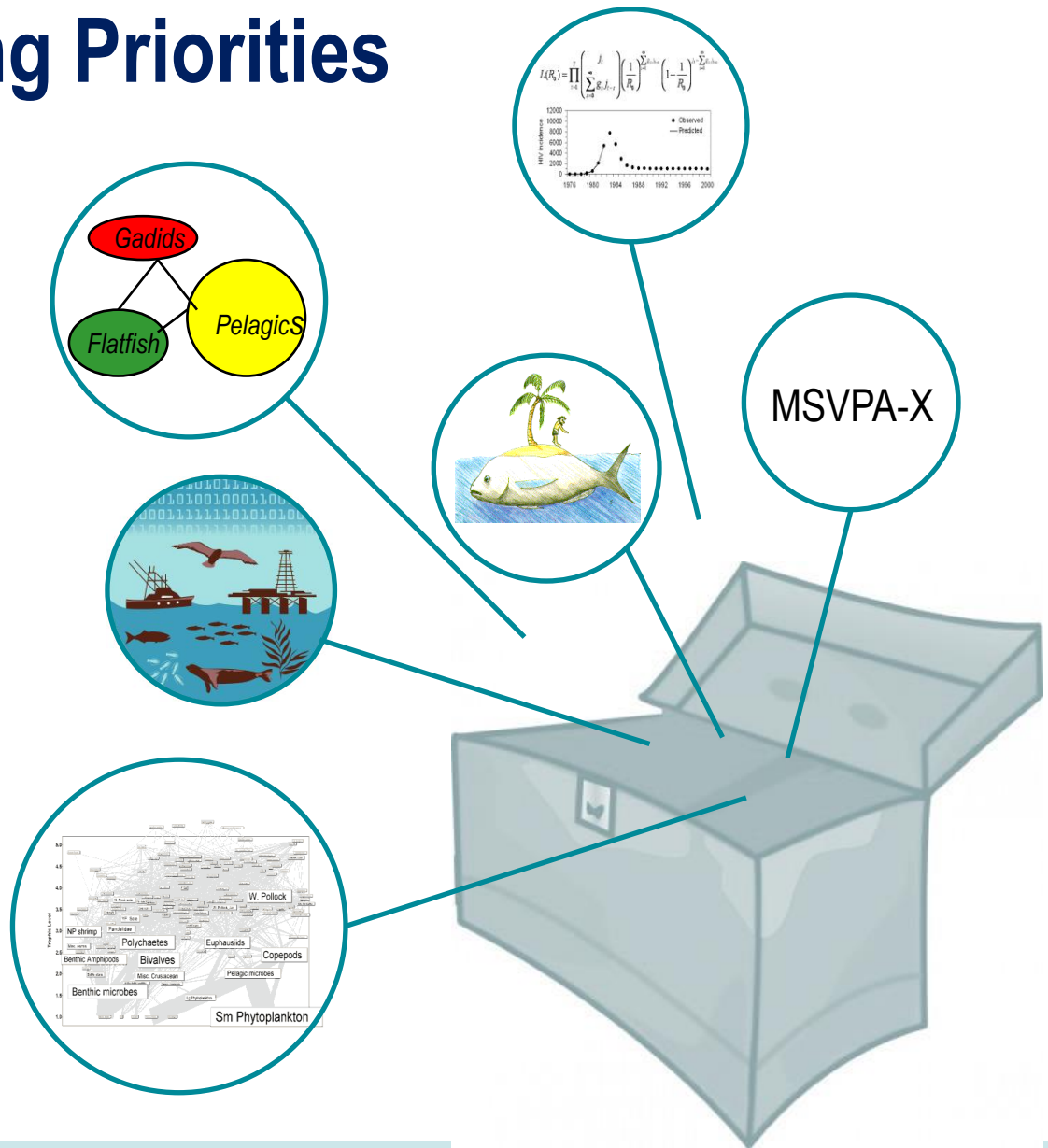


ToR 4: Addressing Priorities

Cataloging
EM activities
at Centers

Consulting
with Centers
on EM priorities

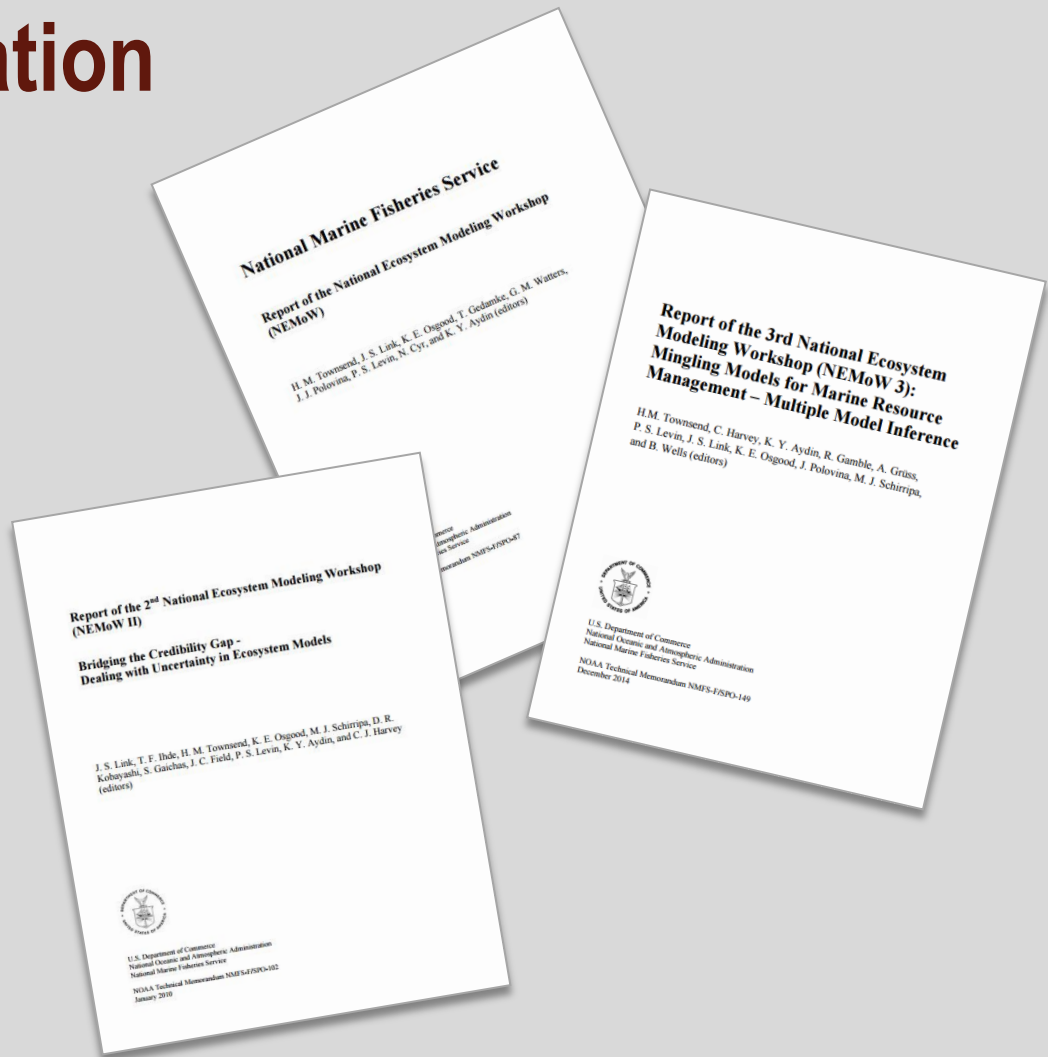
Developing Toolbox
so models can be
more readily
applied and reviewed



ToR 5: Communication

Primarily through
Tech Memos
and scientific
publications

As other aspects
ramp-up
(e.g. Toolbox)
will **develop**
appropriate
comms



Strengths



**Strong
ecosystem
modeling
programs
at some
Centers**

NEMoW:
History of
collaborative
and collegial
interactions
across Centers

**Clear
direction
and goals
in the
EBFM
Road Map**

Challenges and Possible Solutions

Challenges	Possible Solutions
Not all Centers have dedicated EM staff or Models in place to meet LMR management needs	Staff; S&T EM coordinator collaborations; coordination with existing programs
Few Councils have used EM for decision-making	Focused effort on developing ecosystem-level reference points; Development of FEPs; NEMoW to swap ideas on application & operational EMs to address LMR issues
Lack of standard peer-review process for EM	Development of EM Toolbox and review guidelines for tool